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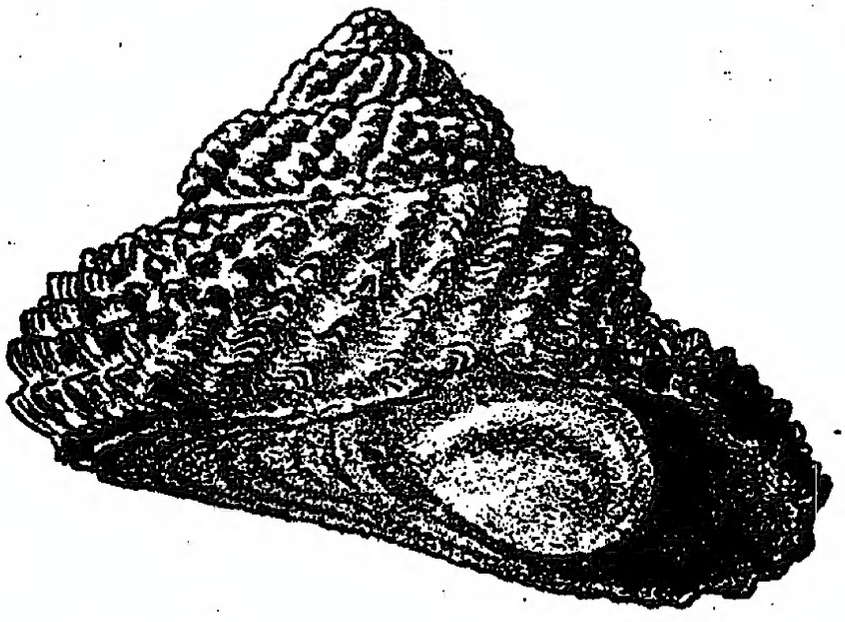

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THE NEW ZEALAND PATELLID LIMPETS IN THE SCHEME OF THINGS

Study Group 24 March, 1977.

F. M. Climo

Introduction:

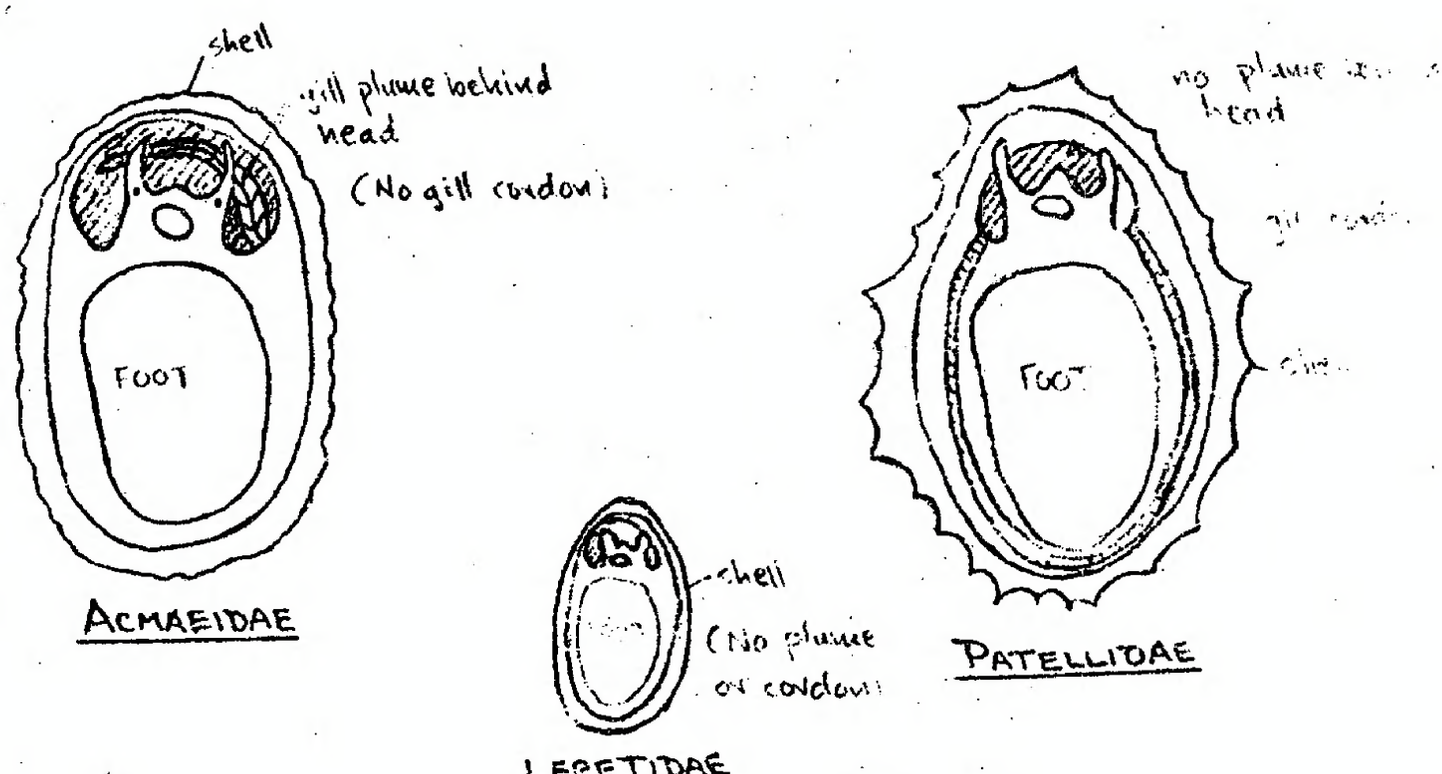
The simple cap-like limpet form has arisen independently several times (from a normally coiled ancestor) in the Gastropoda. The limpet shape provides the greatest amount of suctional foot area for hanging on to rocks in exposed intertidal situations and is also a strong structure from the engineering point of view. The most primitive gastropods to develop the limpet shape were the fissurelids; next in advancement were the patellid limpets (discussed below), followed by capulids, crepidulids and umbraculids; and right at the top are the pulmonate siphon limpets.

All notes for this article have been taken from Doctor A.W.B. Powell's (1973) article in Indo Pacific Mollusca Vol. 3 (15) pp. 75-205 entitled "The patellid limpets of the World (Patellidae)".

Family Composition of Superfamily Patellacea

The term patellid limpet refers to species classified in the superfamily Patellacea Rafinesque, 1815; that is, in its broadest sense. The superfamily is divided into three families with living representatives: Acmaeidae Carpenter, 1857; Patellidae; Lepetidae Dall, 1869. There are also two Mesozoic fossil families.

Classification of patellid limpets is dependent upon a knowledge of the animal. The three families can quickly be recognised by a look at the animal externals. The features of the families are shown in the following figure:



In this talk we are going to look at the New Zealand Patellidae - patellid limpets without a plume behind the head, respiration taking place via a row of gills round the outside of the foot (gill cordon). Members of the Lepetidae are minute and deep water dwellers.

Family Patellidae Rafinesque, 1815

The only representatives of this family on the New Zealand mainland belong to the genus Cellana. Other common genera in the family are Patella and Nacella.

Rock-dwelling patellids feed by moving the head from side to side like a scythe. The tips of the teeth are darkly stained due to the presence of the iron-rich mineral goethite. The mineral hardens the tip of the teeth. After feeding trips limpets often return to the same resting place on the rock. It has been suggested that the iron in the teeth may serve in a magnetic way to guide the homing-limpets back to their resting places - a compass in the mouth!

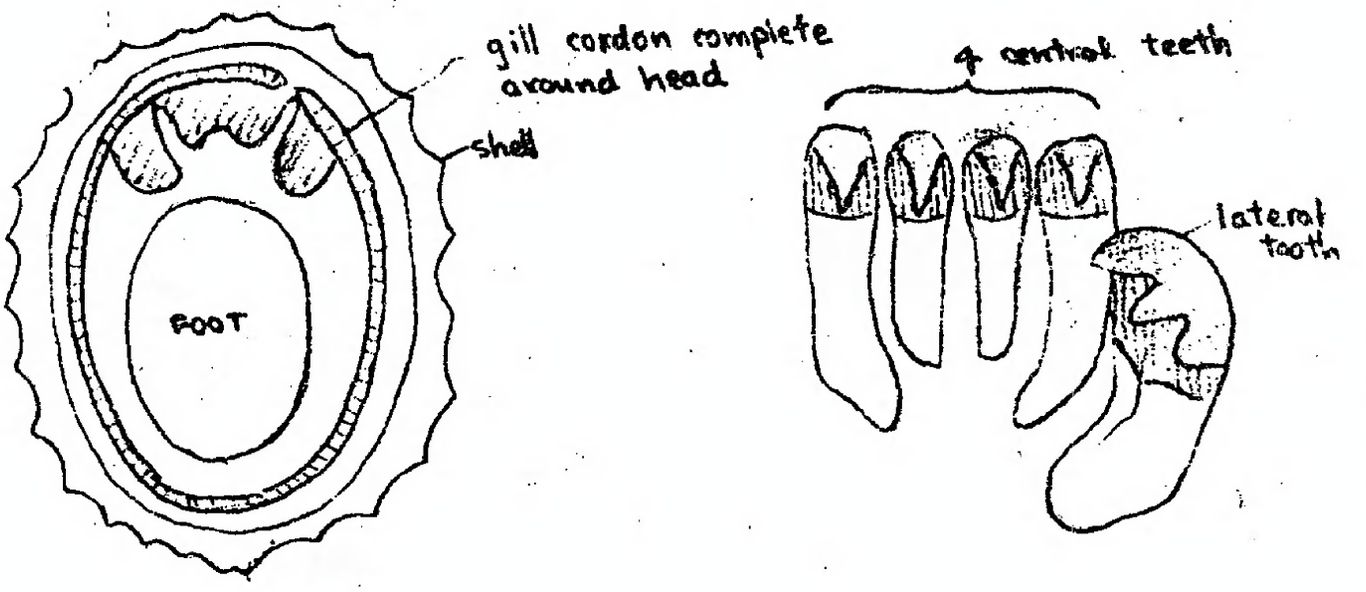
It seems that patellid limpets have a relatively short larval planktonic stage of a few days duration. In Patella young (small) individuals are males and later in life change into females.

Family Patellidae is divisible into two subfamilies :

Subfamily Patellinae Rafinesque, 1815
Based on Patella Linnaeus, 1758

Contains the genera Patella and Helcion and various subgenera of each.

The gill cordon is complete and runs round in front of the head. The radula contains four nearly identical central teeth.



The nearest to New Zealand that a living member of the Patellinae reaches is the Kermadec Islands where the giant Patella (Scutellastra) kermadecensis Pilsbry, 1894 is found. Members of subgenus Scutellastra lived in New Zealand during the Oligocene.

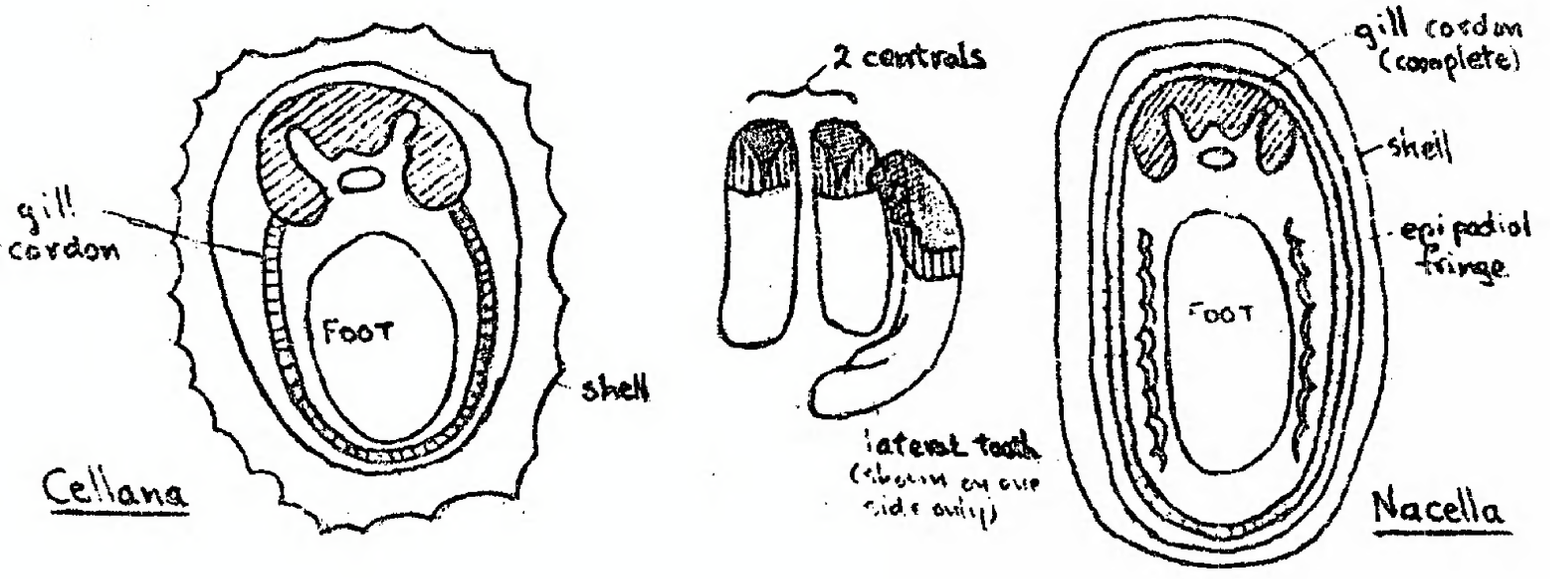
Subfamily Nacellinae Thiele, 1929
Based on Nacella Schumacher, 1817

The subfamily contains Cellana, Nacella and its subgenus Patinigera.

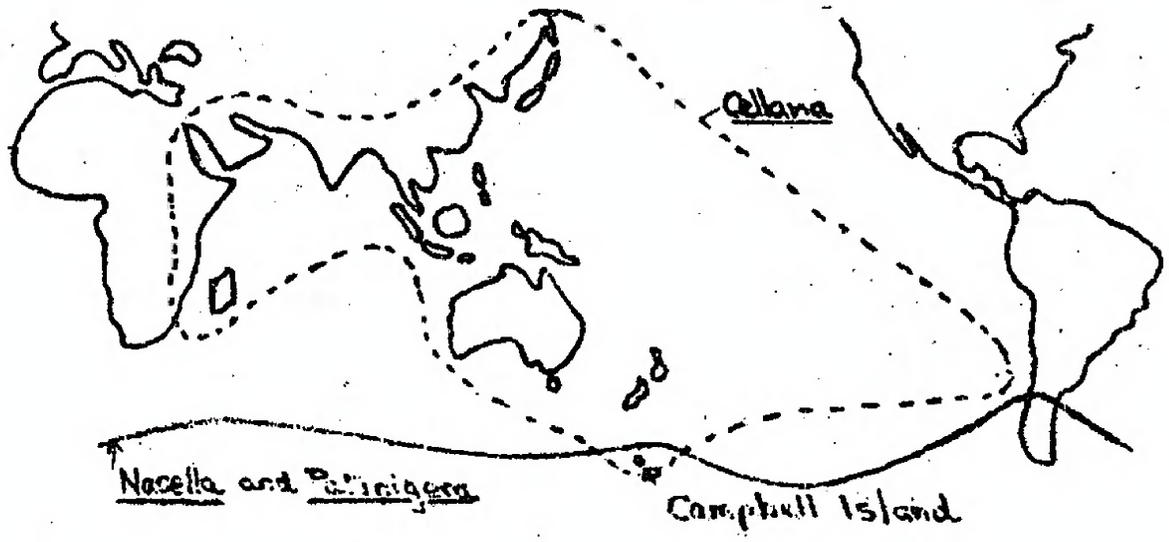
(a) The radular ribbon is extremely long (up to five times length of shell)

(b) There are only two central teeth

(c) The gill cordon is incomplete around the head in Cellana and although complete in Nacella there is an extra structure round the foot (epipodial fringe) which distinguishes these soft parts from the condition in Patellinae.



Members of the Nacellinae have the following global distribution:



Cellana is typically a tropical and temperate water genus, with an Indo-Pacific (mainly) distribution. Its most S. extension is the subantarctic Campbell Island where it lives with Nacella (Patinigera), the only place the latter subgenus is found in the New Zealand region. The cold water genus Nacella extends furtherest north on the West Coast of South America where cold water flows well north.

Genus Nacella Schumacher, 1817

Type species: Patella mytilina Helbling, 1779

The genus is distinguished by its epipodial fringe. In gill features it is like Patella and in radular features like Cellana. Shell thin and fragile or more solid. Typically a coppery metallic lustre to the inside of the shell.

Sub genus Patinigera Dall, 1905

Type species: Patella magellanica Gmelin, 1791

Whereas Nacella is usually thin-shelled and lives mainly attached to large bull-kelps in South America and environs, Patinigera is heavier-shelled, is wider spread, has coarser surface sculpture and lives on rocks. It is, otherwise, apparently identical to Nacella.

Only one species of Patinigera occurs in the New Zealand region.

Nacella (Patinigera) terroris (Filhol,1880)

The crisp growth lamellae on the shell, coppery metallic inner surface and occurence only on Campbell Island distinguish this species which grows to about 60mm.

Genus Cellana H. Adams, 1869

Type species: Nacella (Cellana) cernica H. Adams, 1869

The shell is like Patella but the interior is more highly glazed and irridescent. There are big anatomical differences, too, outlined above.

There are six living species of Cellana found in New Zealand the most southern of which is divided up into 6 subspecies. The most distinctive species are eliminated first, followed by the more variable.

Cellana denticulata (Martyn, 1784)

"The shell is readily distinguished by its prominent brown scaly ribs, netted with brown in the interstices and by its internal coloration, the spatula being cream to orange-brown, and the rest of the interior rayed and netted in dark brown upon a bluish grey ground" - (Powell,1973: 177).

About Kaikoura north, sporadic north of East Cape, extending to the Three Kings Islands.

Cellana flava (Hutton, 1873)

"This bright yellowish to orange limpet, long considered to be only a subspecies of radians, merits specific separation from that species, not only on account of its distinctive coloration but also by virtue of its simple yet relatively constant form of sculpture, short stubby cephalic tentacles, and peculiar vestigial central radular plate" - (Powell, 1973: 178).

Motunau-Amiri area north to East Cape and Te Araroa. Juveniles often have rays of dark brown colour on the shell margin.

Cellana ornata (Dillwyn, 1817)

"In its young non-eroded state this species has a most attractive colour pattern, the primary ribs being lilac-grey, and the intermediate areas purplish brown to black, with the nodes picked out in white" - (Powell, 1973: 179).

Common in the upper intertidal from Northland to Stewart Island.

Cellana stellifera (Gmelin, 1791)

"It is easily recognised by its reddish brown external colour, bluish silvery interior, and usual presence of an apical star in paler colour" - (Powell, 1973: 182).

Found throughout the three main islands of New Zealand, at or just below low spring tide zone.

There remain now two variable species of Cellana to examine :

Cellana radians (Gmelin, 1791)

Common in North, South and Stewart Islands. Occurs in three main colour forms; however, individuals can change from one to another of the colour forms during growth, and intermediate colour forms do exist:

earlii form - brown streaks on the coarse ribs with a cross-connecting pattern giving an overall pattern of broad anastomosing zig zags. More common in the North of New Zealand.

perana form - fine, even radial sculpture with obscure external colour pattern (the ribs darkest) with an internal greenish to golden lustre. This is the dominant southern form.

decora form - colour pattern restricted to radial lines, usually on fairly distantly spaced ribs.

Cellana strigilis (Hombron & Jacquinot, 1841)

This southern species is found in the South Island about as far north as Kaikoura, Stewart Island, all the subantarctic islands and Chatham Islands. A;though having a similar colour pattern to radians with which it occurs in the South of the range of the latter, it is a much heavier, broader-ribbed, smoother external-surfaced and browner base-coloured shell than radians. In the south radians is typically bluish-green in background hue, strigilis is brown.

The various populations of strigilis found in the southern and eastern off-shore islands of N.Z. appear to breed true to form and the local population characteristics have been given subspecific names.

Cellana strigilis strigilis (Hombron & Jacquinot, 1841)

Auckland and Campbell Islands

Cellana strigilis bollonsi (Powell, 1955)

Antipodes Islands

Cellana strigilis chathamensis (Pilsbry, 1891)

Chatham Islands

Cellana strigilis flemingi (Powell, 1955)

Snares Islands

Cellana strigilis oliveri (Powell, 1955)

Bounty Islands

Cellana strigilis redimiculum (Reeve, 1854)

Stewart Island, East and West Otago and North up the East Coast of the South Island to Kaikoura.

The above subspecies are distinguished by a combination of shape, position of apex and the juvenile colour pattern.

The following key is taken from Powell (1973: 183) :-

1. Nucleus at anterior third to seventh of shell

   A. Shell held to light showing pale spots and shapes (ocellate)

      a. Outline broadly ovate
         External colour bluish white, rayed and blotched with light-brown; internal pattern dark-rayed, interrupted at margin.. redimiculum
         External colour almost completely clouded sooty-grey to dark-brown; internal pattern dark-rayed, confluent at margin.... strigilis

      b. Outline narrowly ovate
         External colour almost completely clouded with olive-brown; internal pattern dark-rayed, connected at margin..... flemingi

   B. Shell held to light showing dense pattern of irregular narrow radials

      External colour greenish-grey, with dense pattern of brown radials; internal pattern dark-rayed, interrupted at margin
      Outline narrowly ovate ..... bollonsi
      Outline broadly ovate ..... chathamensis

2. Nucleus at anterior tenth to twentyseventh of shell; shell held to light showing heavy radial streaks; outline narrowly ovate; external colour bluish white, rayed and heavily blotched; internal pattern dark-rayed, interrupted at margin ..... oliveri

AUSTRALIAN CASSIDAE, THEIR DISTRIBUTION PATTERNS AND TRANS-TASMAN RELATIONSHIPS

by W.J. Paul

In "Cookia" Volume I No. I Dr. Beu has listed the New Zealand species of this family and discussed the taxonomy and distribution of the group. Of the seven species recognised in New Zealand, five are also present in Australia. As many collectors will have Australian specimens of these species, it is desirable to have an outline of the distribution of the various species comprising the Australian fauna, and the place occupied therein by the species which have a trans-Tasman range.

The following is a list of the species of Cassidae at present recognised in Australia, with comments on their distribution :

Cassis (Cassis) cornuta Linne 1758

This heavy tropical shell is widely distributed in the Indo-Pacific Region extending from east Africa to the Red Sea and to southern Japan. Hawaii and Tahiti. In Australia it is confined to Queensland and the north coast.

Cassis (Hypocassis) fimbriata Quoy & Gaimard 1833

This is typically a cold water species whose area of distribution extends westward from Portland in Victoria, across the South Australian coast and northwards on the west coast as far as Houtman Abrolhos Islands.

Cassis (Hypocassis) nana Tenison-Woods 1879

Virtually a miniature fimbriata, confined to northern New South Wales and Southern Queensland.

Cypraecassis (Cypraecassis) rufa Linne 1758

The "bull-mouth", so called from the appearance of the aperture, is widely distributed in the Indo-Pacific. Its range almost coincides with that of Cassis cornuta, except that it does not appear to be present in India and Ceylon, and it does extend further down the coast of Africa to Natal. In Australia it occurs only in the very far north of Queensland.

Phalium (Phalium) glaucum Linne 1758

This rather patternless shell is quite rare in Australia, occurring only in northern Queensland. It extends however over the greater part of the Indo-Pacific, but not eastwards of the Solomon Islands.

Phalium (Phalium) bandatum bandatum Perry 1811

In Australia this is a common shell from New South Wales along the Queensland coast and westwards to the Houtman Abrolhos Islands. The remainder of its distribution area consists of a strip from Australia to Japan. A separate subspecies occurs in the Seychelles and Mascarenes.

Phalium (Phalium) areola Linne 1758

The checker board pattern of this shell is very distinctive. It is common in Australia from northern New South Wales northwards and westwards to Broome. Outside Australia it ranges from east Africa to Japan and out into the Pacific as far as Samoa.

Phalium (Echinophoria) coronadoi wyvillei Watson 1886

This is a deep water species, the typical form of which is in western Atlantic waters. The subspecies wyvillei occurs in depths from 100 to 567 metres from Japan to Australia. The only Australian record is from a fish trap in 60-80 fathoms off North Solitary Island, Wooli, New South Wales.

Phalium (Echinophoria) kurodai Abbott 1968

Three specimens of this species were trawled in 145 metres off Cape Moreton, Queensland in 1976. This was the first record of the species in Australia. It had hitherto been considered to be confined to Japan.

Semicassis bisulcatum Schubert & Wagner 1829

An extremely variable species of wide range from East Africa to the Red Sea, to Japan, to New Hebrides and including Australia from Shark Bay to soutern Queensland. Many collectors will have known this as S. diuturna, Iredale 1927.

Semicassis sophia Brazier 1872

Abbott treated this as a subspecies of bisulcatum, but its tabulated shoulders, almost smooth surface and broader columellar shield make it quite distinctive. It is found only in South Queensland and northern New South Wales.

Semicassis glabratum angasi Iredale 1927

This subspecies of glabratum is confined to Australia from around the Kimberley area in the north west to New South Wales.

Semicassis glabratum bulla Habe 1961

A deep water subspecies of glabratum previously considered to be confined to an area extending from Japan to the south east coast of China and to Hawaii. It has, however, been collected in 80 fathoms off Cape Moreton, Queensland.

Semicassis (Antephalium) semigranosum Lamarck 1822

Confined to the wouthern waters of Australia, this species is common in Tasmania and Victoria, not so common in South Australia, and a thinly spread population extends into West Australia to about Fremantle.

Semicassis (Antephalium) adcocki Sowerby 1896

Very few specimens of this species reach private collections. Abbott commented that "not more than a dozen specimens are known". This is definitely an understatement, but the fact is that this is a rare shell. A specimen of adcocki gained the distinction of "Shell of the Show" at the Third Australian Shell Convention in Perth in 1974. It has been collected at several localities from Bass Strait to Eucla in The Great Australian Bight.

Semicassis sinuosum Verco 1904

This is even rarer than adcocki, although Verco obtained 22 by dredging in Backstairs Passage. Since then very few specimens have been collected, and it is almost unknown in private collections. The few that have been collected have come from widely scattered localities from Bass Strait to Binningup in Western Australia.

Semicassis pyrum Lamarck 1822

The type-locality of pyrum is believed to be southern Tasmania. Throughout southern Australia are a number of shells which have been given separate names by authors who have not had adequate comparative material. The small differences between many of these forms, together with the large number of intermediate forms now known, clearly make these separately named shells to be forms of pyrum. The following is a list of names applied to cassids of south and south east Australia which are synonyms of pyrum :

denda Cotton 1945
wilsoni Cotton 1954
halli Cotton 1954
mawsoni Cotton 1945
turgida Hedley 1902
stadiale Hedley 1914
tumida Petterd 1886
spectabile Iredale 1929
niveum Brazier 1872

The degree of variation among these forms is quite remarkable but, just as remarkable, is the number of variants which fit in between them. Tasmanian specimens from a number of localities are quite indistinguishable from New Zealand ones, and many Victorian specimens are closer to New Zealand ones than to specimens collected in other parts of Victoria. Some shells from South Africa have been attributed to this species, but some doubt must be placed on this as they tend to show features not typically pyrum but rather pyrum-labiatum facies.

Dr Beu has dealt with the names previously used in New Zealand which must now be considered synonyms of pyrum.

The geographical range of pyrum in Australia is from mid New South Wales through Victoria to South Australia and all round Tasmania. The shells

which some authorities have treated as pyrum from South Africa have been collected off Mussel Bay in 60 fathoms and from stomachs of fish taken off Durban.

Semicassis royanum Iredale 1914

The type locality of royanum is Sunday Island (Raoul Island) in the Kermadec group. Typical specimens are collected off the east coast of northern New Zealand. The form which Powell named ericanum is in fact a form of royanum. Off the coast of New South Wales is a very similar form which Iredale named hedleyi. This is another synonym of royanum. The total area of distribution of royanum is a band reaching from New South Wales to northern New Zealand and including the Kermadecs.

Semicassis pauciruge Menke 1843

This West Australian species is confined to an area extending from Esperance to Shark Bay.

Semicassis thomsoni Brazier 1975

The Australian distribution of this species consists of an area extending from northern Tasmania to Moreton Bay, in Queensland. In New Zealand it has been collected at several localities from the Bay Plenty northwards. A small form with heavy nodulation and a wrinkled appearance found around Port Jackson was named palinodium by Iredale, but it is in fact an ecological variant of thomsoni.

Semicassis whitworthi Abbott 1968

This very distinctive heavily sculptured shell appears to have been obtained only from crayfish pots in the area between Rottnest Island and Geraldton in Western Australia. Very few have been collected.

Semicassis labiatum Perry 1811

The variation of labiatum in both New Zealand and Australia has led to several names being introduced and some confusion as to their validity. To make the situation more complex, not only are New Zealand and Australian shells assigned to this species, but a South African and a South American shell are now recognised as subspecies of labiatum.

The three subspecies now recognised are ...

labiatum labiatum Perry 1811
Distributed from Victoria to South Queensland, Norfolk Island and northern New Zealand
(collactea Finlay 1928 and insperata Iredale 1927 are synonyms)

labiatum iredalei Bayer 1935
Distributed in Cape Province and Natal, South Africa. In a number of publications on South African shells this is recorded as achatina Lamarck.

labiatum iheringi Carcelles 1935
Distributed from northern Argentina to Uruguay and southern Brazil.

Casmaria erinaceus erinaceus Linne 1758 (= vibex Linne 1758)

A widely distributed shell in the Indo-Pacific, ranging from East Africa to the Red Sea, to Taiwan and the central Pacific. In Australia it is found from about half way up the Queensland coast to Point Cloates in West Australia.

Casmaria ponderosa ponderosa Gmelin 1791

This species inhabits an area extending from East Africa to Polynesia. In Australia it is found from south Queensland to Thevenard Island in the north west.

Casmaria ponderosa perryi Iredale 1912

A rather unusual range is occupied by this subspecies which is found in New South Wales, northern New Zealand and Easter Island; also the Kermadecs.

Morum (Oniscidia) grande (Adams 1855)

This is one of the species of molluscs earlier considered as confined to more northern waters, and which have been located in Queensland waters in recent years. It has a range from Japan to Queensland.

Morum (Oniscidia) bruuni (Powell 1958)

This species is known at present only from New South Wales and the Kermadecs.

The 27 species and subspecies of Cassidae in the Australian fauna can be summarised as to their distribution areas as follows :-

... Area of distribution	... Number of species
Australia only (endemic)	9
Australia and Indo-Pacific	13
Australia and New Zealand only	3
Australia, New Zealand and Indo-Pacific	2
	27

NEW ZEALAND MEMBERS OF FAMILY CALYPTRAEIDAE
Notes for Study Group 22 July 1976
(Revised version of a 1972 Study Group)

F. M. Climo

The Slipper Limpets (family Calyptraeidae) are an incompletely understood group in New Zealand. This will be obvious from points in the discussion on each species.

Family: CALYPTRAEIDAE

"Shell conic, patelliform, the summit more or less spiral; interior polished, porcellanous, chambered by a basal plate or variously shaped process, supporting the viscera; peristome entire. No operculum or attached base.

The Calyptraeidae are found adhering to stones and shells; most of them appear to never quit the spot on which they first settle, as the margins of their shells become adapted to the irregularities of the surface beneath. The form and colour of the shell both depend somewhat upon the situation in which it grows; those found on the ide of the mouth of dead shells are generally flat or even concave above, and white; those attached to the outside of shells are convex and ccloured. The animal is supposed to feed on seaweed and animalcules. They sometimes cover and hatch their spawn under the forepart of the foot" (Suter 1913: 283).

Genus: Sigapatella Lesson, 1830
Type species: Calyptraea calyptraeformis Lam., Recent, Aust.

Pertinent parts of Suter's (1913: 285) diagnosis of the genus are presented below: "Spire small, conic, salient, lateral and posterior Protoconch small, of 1½ convex whorls, the first smooth, the following half with a few microscopic growth-lines and spiral striae. Whorls 3 to 4, convex, the last very large"..."Columella lateral, dilated at its insertion, and furnished with a triangular lamina, which partly hides the rather wide false umbilicus".

S. terraenovae Peile will be considered first, because in the past, Smith (1915: 83) recorded the New Zealand specimens as the Australian calyptraeformis. Peile (1924: 22) erected terraenovae for this New Zealand record and compared the radula with the Australian species. Finlay (1927: 392) added further conchological comments on the two and made comparison with novaezelandiae.

Sigapatella terraenovae Peile, 1924

Synonyms: Sigapatella calptraeformis (Lam.), Smith,1915: non calyptraeformis Lamarck

Zegalerus tumens Finlay, 1930 (½ grown terraenovae: Dell,1956:71

S. calyptraeformis and S. terraenovae are compared below (from Peile); terraenovae will be compared further below with novaezelandiae and spadicea.

calyptraeformis	terraenovae
denticles go to tip of lateral tooth	lateral teeth with broad, triangular point
about 34 rows of teeth	47 rows of teeth
suture well marked	suture less well marked
surface flattens on edge giving a sharp keel	convexity of surface persists to periphery
smooth, close, growth ridges	rougher, widely spaced ridges
periostracum brown and dense-square ended blades	periostracum lighter and less dense
base white in adults	base usually coloured in adults

Distribution Finlay (1927: 392) regarded this as a northern deep water species (e.g. 40 fathoms near Cuvier Island) being replaced further south by deeper water extensions of Z. tenuis or S. novaezelandiae.

Dell(1956:70-71) came to the conclusion that specimens of terraenovae illustrated by Mestayer (1928:622-3), and reputed to have been compared by Peile (1924) with his types were, in fact, Z. tenuis. He then went on to try and determine which northern shells could have been attributed to S.calyptraeformis by such an experienced conchologist as E.A. Smith, and came to the conclusion, that in size, shape and sculpture, half-grown specimens of Z. tumens Finlay,1930 "are very close indeed to Sigapatella calyptraeformis (Lam.)" At the moment, tumens appears best treated as a synonym of terraenovae.

Sigapatella novaezelandiae Lesson, 1830

Diagnosis is best made by comparison with terraenovae (above) (from Finlay 1927: 392).

novaezelandiae	terraenovae
open umbilicus	umbilical chink only
shell less circular	shell more circular
excentric nucleus	less excentric nucleus

4 coarse, irregular spiral cords on base of protoconch	numerous flat ribs on base of protoconch

Distribution: Widespread in New Zealand waters and overlapping with terraenovae in northern New Zealand in deeper water. The spiral striae on the base of the prontoconch confirm its placing in Sigapatella, one of the most characteristic features of the genus.

Sigapatella superstes Fleming 1958

"Shell large, robust, haliotoid, roundly oval in plan, with excentric spire; Apex not prominent, about one-fourth diameter from periphery. Protoconch worn in all specimens, but apparently similar to novaezelandiae. Post-embryonic whorls as in S. novaezelandiae but generally more evenly inflated, Sculpture of numerous concentric growth folds, irregular in strength and spacing, and of fine spiral threads, interrupted and irregular in direction where they cross the growth lines, resulting in a fine granulated surface-texture over the whole dorsal surface of both adult whorls. Suture well defined. Basal plate concave, with open umbilical chink" (Fleming, 1958: 141-2).

Distribution and remarks. From beach drift at Cape Maria van Diemen (with S. novaezelandiae and terraenovae (= Z. tumens) and dredged around the Three Kings Islands.

"S. superstes is distinguished from S. novaezelandiae and from its predecessor, the Mid-Tertiary S. mapalia Marwick, by conspicuous granular spiral sculpture and from the type of the problematical S. terraenovae Peile (see Dell, 1956: 70), also described from Northland, by its shape, sculpture, and pronounced umbilicus" (Fleming, 1958 (141-2).

"Sigapatella" spadicea Boshier, 1961

Before making comparisons here, we have to look at Boshier's (1961: 105) description of the protoconch. where it is stated; "Protoconch smooth, slightly tilted, discontinuity between protoconch and juvenile whorls very slight". If Sigapatella, with spiral striations on the base of the protoconch, is going to have any meaning as a genus I cannot see why spadicea, with its smooth protoconch, should be placed in Sigapatella.

Comparison was made with Z. tenuis and S. tumens and the diagnosis and points from this comparison are listed below :

"S." spadicea	S. terraenovae (= tumens)
chocolate brown colouration	lighter colouration
no umbilical channel	narrow umbilical channel

spadicea	Z. tenuis
tall	short
umbilical depression	no umbilical depression

"Until we have the animal of the species and can compare its anatomy and morphology with that of Z. tenuis (Gray), S. terraenovae Peile, and Z. tumens Finlay, and also know the limits of its geographic range, we cannot be definite in ascribing to it full specific rank. The present state of knowledge however, after comparative studies of the shell form, and consideration of the colouration and umbilical character, justifies erecting the new species".

"S. spadicea has been collected rarely from Cape Maria van Diemen; from Russell, Bay of Islands, in 5 fathoms; and from as far south as Foveaux Strait in 20-40 fathoms" (Boshier, 1961:105). The type locality is North of Kapiti Island in 30 fathoms.

Remarks 1. How significant are the comparisons between "no umbilical channel but with umbilical depression" (spadicea) and "narrow umbilical channel" (terraenovae = tumens) or "no umbilical depression" (Z. tenuis)?

2. In terms of geographical range, spadicea as discussed by Boshier overlaps all but the Chatham Islands Z. crater, so I fail to see how more localities are going to determine its status as a full species.

3. Shell shape is virtually useless, so is colour.

4. If its specific status has to be confirmed by comparison with anatomy of Z. tenuis, S. terraenovae (or Z. tumens), this is surely a strong admission that shell features are virtually useless in determining whether a species belongs to Zegalerus or Sigapatella, in Boshier's eyes at any rate.

Genus: Zegalerus Finlay, 1927
Type Species: Clypeola tenuis Gray, 1867

Gray (1867: 735) lists two species under Clypeola, the first the South American magellanicus Reeve, describing as new, tenuis. Apparently, the South American and New Zealand species are not congeneric because Clypeola is a valid genus for this group of molluscs (Agassiz, 1848:261; Neave,1940; Sherborn, 1902;1101; 1921;1369). Clypeola is apparently a synonym of Trochita Schumacher, 1817.

Zegalerus, as far as I can see, has been erected in a rather roundabout and undefined way. I quote from Finlay, 1927:392: "It is probable that there are many forms of the "scutum" series, for Smith separated the Australian shells from the Neozelanic ones, calling the former hedleyi, the latter being tenuis Gray. Though never explicitly stated, the types of Smith's hedleyi were South Australian shells sent to Verco (information from T. Iredale). Shells of this style, tentatively named hedleyi, from Twofold Bay, are much higher than Verco's specimens. The radulae of these shells and radula of the Neozelanic tenuis differ from that of the Sigapatella series. The central tooth approaches much more closely to that of chinensis Linne, the type of Calyptraea Lamarck 1799 .... and the shells are conchologically easily separable, so that for this group I propose Zegalerus nov., naming Clypeola tenuis Gray 1867 as type".

Remarks: 1. So, what are the central tooth features of chinensis?

2. What are the conchologically easily separable shell features? Boshier did not apparently know what they were and Finlay placed tumens in Zegalerus, while it seems likely that it is a Sigapatella.

As far as I can make out, nobody has defined the features of Zegalerus. At the moment it would appear that Zegalerus is a tall, centrally-pointed calyptraeid, with a sharp periphery, the protoconch does not have spiral striations on its base, and with the central tooth of the radula similar to that of the type of Calyptraea (according to Finlay, 1927).
The establishment of the status of Zegalerus must await a more thorough appraisal than this quick skim through the literature, and for the moment the genus is used, however sketchily defined.

Zegalerus tenuis (Gray, 1867)

The familiar little pointed "Chinaman's Cap Shell", usually collected bleached and white on beaches, the fresher specimens having a bluish tinge. Widespread in New Zealand.

Zegalerus crater Finlay, 1927

This is a species of rather doubtful status, compared by Finlay (1927: 392-33) with tenuis; my summary below:

crater	tenuis
larger	smaller
tall conical form	flatter
solid shell	less solid shell
coarse texture	finer texture
sides straighter	sides more curved
whorls more concealed	whorls less concealed
growth-lines concentric circles	growth-lines logar, spirals
almost no tendency for last whorl to flatten out	last whorl usually flattens out
no hollow axis	hollow axis
protoconch projects laterally and obliquely	protoconch more regular spiral and juts more vertically

inner embryonic whorl inrolled and hidden by outer	inner embryonic whorl generally rising above outer and not obscured by it

The tall conical form of crater may be a purely ecological expression of the type of substratum the animal is living on, the hollow axis a direct corollary with this more "humped" shape. The difference of degree in protoconch shape are also suspect as good systematic characters. In animals living on a variety of substrates in variable depths and isolated, often, into restricted populations, shape is hardly worthy of mention, as is the case with limpet outlines.

The type specimen is a Pliocene shell from Petane while the species has been recorded Recent from the Chathams.

The ease of recognition of the species is best summed up by Finlay: "As a species this is not always readily separable from tenuis Gray: adults are easily distinguished by their much larger size and tall conical form, but juveniles of the two forms are often deceptively alike." He then goes on to list the protoconch and etc. differences listed in my comparison. =

The key to much of the confusion in trying to define species mentioned above probably lies in the type of larval development. As far as I am aware, the spawn develop, hatch and settle in close proximity to the parent shell. The larvae are probably not long sustained which leads to the development of local population traits. Combine this with ecological response to different substrates and depths, and there results a bewildering array of shapes, (e.g. examine the National Museum ref. coll. of tenuis sometime). Add to this the difficulty in deciding where a Zegalerus finishes and a Sigapatella starts and the systematics are really confused. We do not have enough basic anatomical data yet to sort out this confused state of affairs. Do, for example, Sigapatella and Zegalerus intergrade and do we have the following arrangement for the species discussed above:

Sigapatella novaezelandiae

Sigapatella superstes

Sigapatella terraenovae Syns crater
tumens
spadicea

Sigapatella tenuis

The specific identity of tenuis will have to wait examination of the type. There occur in most places south of North Cape two forms of tenuis - one a small tall shell like the spadicea form of terraenovae, with a periostracum and a flatter, nude shell. It is possible that tenuis might be a small southern form of terraenovae in which case it becomes the name to use for this complex while the flat one needs naming. On the other hand the type may be a flat shell and the above situation will stand. I've treated tenuis above as if the second alternative stands, but that is purely a guess.

Genus: Maoricrypta Finlay, 1927
Type Species: Crepidula costata Sowerby, 1824

A group of Crypta (= Crepidula) - like species, confined to New Zealand and having a diverse fossil history here, with the shell features of the "Ribbed Slipper Shell". Apex smooth and glossy, passing directly into the crude corrugations of the adult sculpture. Animal features known insufficiently well for comparison with the extra-Neozelanic taxa.

Subgenus: Maoricrypta s.s.

Maoricrypta (Maoricrypta) costata (Sowerby,1824)

The "Ribbed Slipper Shell" is recorded from central New Zealand northwards. It is commonly heavily ribbed and has dark chocolate, wavy, radial bands of colour. Specimens grade, however, through to nearly smooth with colour bands only and with very thin shells (trawled Bay of Plenty). Very tall, small, weakly ribbed and weakly colour-marked specimens occur in Wellington Harbour.

I have been tempted to place M. youngi Powell, 1940, within this range of variation, but here, with a species restricted to the northern Northland area, one has to bear in mind Fleming's (1958) theory that this northern part of New Zealand could be a refuge for many species that were pushed north from the rest of New Zealand during cold phases of the Pleistocene glaciations. M. youngi could well be a little understood northern species; certainly the combination of colour, protoconch projection, sculpture and geographic range are factors suggesting this. Bruce Marshall is examining the animal of specimens collected on the "R.V. Acheron" Northland Expedition of 1974, so we should have evidence one way or the other soon.

Maoricrypta youngi Powell, 1940

Comparison with costata below, after Powell (1940: 232):

youngi	costata
Sculpture malleate	: sculpture nearly smooth - radially ribbed
beak narrow and strongly projecting regardless of shell shape	: beak not so strongly projecting
colour buff with faint longitudinal brown streaks	: colour variable, but not often darkly unicoloured

Distribution Poor Knights area north to Cape Maria van Diemen.

Subgenus: Zeacrypta Finlay, 1927
Type species: Calyptraea monoxyla Lesson, 1830

Defined as follows by Finlay (1927: 393): "Whereas the apex in the costata series is smooth and glossy, passing directly into the crude corrugations of the adult sculpture, the monoxyla line has developed an intervening brephic stage which forms a large slightly raised ellipsoidal cap (with the flatly coiled smooth embryo at one of the foci) ornamented all over with fine threads radiating from the embryo. The "Miocene" ancestor of monoxyla has the same feature, only the threads are fewer and wider: this stage has evidently developed long since, and never appears in the costate forms; I therefore emphasize the distinction of the parasitic group by providing Zeacrypta nov. for monoxyla Lesson at present allowing it sub-generic rank under Maoricrypta".

Remark: Finlay's use of the word "parasitic" will be discussed below under the species.

Maoricrypta (Zeacrypta) monoxyla (Lesson, 1830)

The "Smooth" or "White Slipper Shell" found throughout New Zealand. Most often met with in its flattened form, replicating the surface on the interior of dead gastropod shells. Less commonly. high, rounded specimens are collected from the surface of gastropods such as Lunella in northern Harbours, or intermediate shells in similar situations from the outer surface of live Perna.

Remarks: Finlay uses the term "parasitic" incorrectly. This term cannot be used for a shell occupying a dead shell, because it obviously has no host from which to gain nourishment. There would not be room in an aperture even for a symbiotic or mutualistic relationship in the case of interior habitation of a gastropod substrate shell occupied by its animal. Mutualism or otherwise has yet to be demonstrated for specimens of monoxyla living on the outside of Lunella or Perna; though it appears doubtful to me. At the most, M. (Z.) monoxyla possibly forms some relationship with a hermit crab - polychaete inhabited shell -, perhaps with an anemone attached. These combinations often occur in dredgings but it appears doubtful that any of the combinations are obligatory; i.e. essential for the survival and well-being of any one of the associated animals. Neojanacus perplexus Suter, 1907, is often associated with hermit crabs in the apertures of dead shells in deep water (over 200 fathoms) in New Zealand.

For the word "parasitic" of Finlay's usage, substitute "internally attached".

Following from above, take Finlay's (1927: 393-4) statements : "the reference of the high, nonparasitic forms to monoxyla is doubtful; they seem quite distinct specifically, possibly generically, and may indeed be degenerate forms of Maoricrypta. One may recommend investigation of this problem and I suggest that only the flattenad parasitic forms are true Zeacrypta monoxyla".

There seems little doubt that the tall, rounded specimens are Zeacrypta Several lots in National Museum Collection from the surface of Perna and Lunella have juveniles with the protoconchs sufficiently clean to see pronounced radial ribs, which not only radiate from the protoconch backwards, but also radiate for a short distance in front of the apex. This is not just a feature of externally attached shells; flat, internally attached juveniles also show these anterior threads. What does need testing is whether the externally attached shells in northern harbours are the same species as the widespread internally attached monoxyla.

The apical ribs are not entirely absent from Maoricrypta s.s; Two specimens dredged from Bay of Plenty have weak, distantly spaced radials on the protoconch, which is also delineated as a separate part of the shell. The distinction between the subgenera holds but it is, apparently, not as absolute as stated by Finlay. One wonders just how useful the distinction is anyway.

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NEW ZEALAND SHELLS IN AUSTRALIA

by W. J. Paul

We are all aware of the Australian origin of a considerable portion of the New Zealand molluscan fauna. Not so well known, however, is the fact that a number of New Zealand endemic species have been transplanted into Australian waters and have become established populations there. How this has happened is not well recorded in all cases. Obviously, however, human agency has been responsible. Sporadic introductions of New Zealand oysters occurred in eastern Tasmania in the 1880's and again in the 1920's. It is known that oysters from New Zealand for sale in Hobart were kept alive in crates submerged in the harbour area. With the oysters may have been included juveniles of several species of molluscs. Whether any of the oyster populations in Tasmania originated from New Zealand stock is beyond establishment insofar as,despite a mass of literature on the subject, the final word has not been said on the differentiation of the species of oysters in Australasian waters. In the following notes is some information on some New Zealand shells now well established in Australia :=

Paphirus largillierti (Philippi 1849)

Well established populations of this species exist in eastern Tasmania. The check-lists of Tasmanian shells published by May (1923) and Kershaw (1955) do not mention the species. It has now been shown that the shells these authors recognised as species of Katelysia are in fact Paphirus largillierti. Recent thorough collecting has revealed no Katelysia species in the area where these authors recorded them. Specimens I have from the area are definitely Paphirus, but at first glance could be mistaken for Katelysia rhytiphora. When Paphirus largillierti was introduced into Tasmania is not known.

Neilo australis (Quoy & Gaimard 1835)

Specimens of this species have been obtained in several locations in the Derwent Estuary. They are believed to have been introduced with oysters.

Amaurochiton glaucus (Gray 1828)

This chiton is well established in the Derwent Estuary. The general opinion is that it has been carried by shipping. Specimens of this species are not uncommon on the hulls of boats and the progenitors of the Tasmanian population no doubt arrived in this manner.

Maoricolpus roseus (Quoy & Gaimard 1834)

This shell was not recorded by May when he did extensive dredging in the D'Entrecasteau Channel in the 1920's. His work on the molluscan fauna of eastern Tasmania was very thorough, and it would be most surprising if he had missed a species of this size. This shell is, however, quite plentiful in that area today. Maoricolpus roseus was collected in the Channel as early as 1945, so it is obvious that it arrived somewhere between the 1920's and the 1940's.

Specimens of Maoricolpus roseus have also been recorded from the west coast of Tasmania and in recent years from southern Queensland. Garrard in his excellent review of the Australian Turritellidae has suggested that the long pelagic existence of the veliger stage could possibly account for transport of juveniles in bilge water or ballast water.

Zeacumantus subcarinatus (Sowerby 1885)

This shell was known to Finlay in 1926 to be "extremely common and spreading rapidly at Freshwater, near Manly, Sydney". It was not listed in Hedley's 1918 check list, so presumably was introduced some time between 1918 and 1926, but exactly when or by what means is unknown. It is the only species of Zeacumantus in New South Wales. The Australian native species Z. diemenensis (Quoy & Gaimard 1834) is confined to Tasmania, Victoria and South Australia.

Perna canaliculus (Gmelin 1791)

A.J. Dartnall of the Tasmanian Museum in his paper "New Zealand Marine Animals from Channel Waters" (Tasmanian Fisheries Research Vol. No.1 (1967) commented that this species had been recorded as being introduced with New Zealand oysters. Apart from this reference I have not been able to obtain any data on the subject.

In addition to molluscs several other marine animals have become established in Australia from New Zealand.

One of our five-armed sea stars, Patiriella regularis, and a spider crab, Halicarcinus innominatus, have both been recorded in Tasmania. These probably arrived with oysters, as also did the brachiopod, Terebratula rubicunda. The New Zealand mud worm, Polydora, by some mischance was introduced into New South Wales about 1870 with disastrous results to the oyster production.

THE GEOLOGY OF THE WANGANUI AREA

A. G. BEU

Wanganui City is sited near the centre of a large sedimentary basin that filled slowly with fossiliferous, shallow water rocks throughout Pliocene and early Pleistocene time; that is, from about 5 million years ago to about 300,000 years ago. These rocks have been very little deformed and compacted since they were deposited, so the fossils in them are beautifully preserved and easy to collect and to clean, and as they are almost identical to the shells living on the inner part of the continental shelf off the western North Island today, shell collectors find these shells more interesting than most.

Dr Fleming has described all the geological features and geological history of the Wanganui area in detail in Geological Survey Bulletin 52 and this paper is a summary of this work.

The centre of the Wanganui sedimentary basin is close to the town of Marton, and because the land all around the basin was gradually rising at the same time that the basin was sinking and being filled with sediment, the rocks of the basin all dip inwards towards the Marton area. This means that as you travel up the Wanganui River, or better still up the very thick continuous sequence in the Rangitikei River, you pass through rocks sloping very gently downwards towards the coast, and you gradually pass through older and older rocks at the surface of the land. This also happens along the magnificently exposed section in the coastal cliffs west of Wanganui, from Waverley Beach to Castlecliff.

There are three ways of classifying rocks. Firstly by the rock type, into units called formations and groups. The second is by their age either in millions of years, or into internationally recognised epochs, periods and eras, based on the rock sequences in Europe and using terms such as Pliocene and Pleistocene. The third is a sort of combination of the other two methods, using local fossils to recognise rocks deposited during given periods of time; leading to division of the New Zealand-wide sequence of rocks into Stages and Series. At the end of this article is a diagram showing the Stages and epochs seen in the Wanganui coastal sequence. The rocks are about 3 to 0·3 million years old, and fall into the European-based Pliocene and Pleistocene epochs. The sequence also provides the standard reference sections for all of New Zealand through the Waipipian

Mangapanian, Nukumaruan and Castlecliffian Stages, and the Putikian and Okehuan substages of the Castlecliffian.

At the end of this article is a copy of Dr Fleming's diagram of the rocks to be seen in the coastal sequence between Nukumaru and Castlecliff, which shows the 30 or more formations he recognised and the boundaries between the Nukumaruan and Castleciffian Stages and the Okehuan and Putikian Substages. The vertical scale of the diagram is approximately twenty times as great as the horizontal scale, so the dip of the rocks appears very much greater than you see when walking along the cliffs.

Starting at Nukumaru the shallow water limestone and soft brown sandstone contain abundant, usually chalky, shallow water and estuarine shells such as volutes, Tawera, Dosinia, Cominella, and some that don't live in New Zealand now such as Lutraria (a large, elongate mactrid) and Zenatia (Zenatraria). The rocks overlying the brown sand were deposited in very shallow water or in fresh water, so from about the centre of Nukumaru Beach eastward to about half a mile east of Ototoka Stream there are no fossils of any interest to shell collectors. In the bluff to the east of the mouth of Ototoka Stream, and descending to beach level about half a mile further east is the lowest bed included in the Castlecliffian, the Butler's Shell Conglomerate (named after Ototka Stream which used to be called Butler's Stream) Occasional nice fossils fall out of this unit onto the scree at the foot of the bluff. From here almost to the Pinnacles, the main rock type is what the early geologists called the Kai Iwi blue siltstones, several beds of soft blue grey siltstones withintervening thin shelly horizons, each given its own name by Dr Fleming. The siltstones contain sparso but very interesing fossils that lived in deeper water than those from the Castlecliffian end of the section such as Tellinella, Globisinum, Struthiolaria (Pelicaria) vermis grahami and an extinct, finely sculp tured species of Aeneator. The best place to collect fossils from the siltstone is in the cliffs east of Mowhanau Beach, from the Lower Kai Iwi Siltstone, Omapu Shellbed, and Lower Westmere Siltstone where they are relatively common and beautifully preserved.

The Putikian or younger substage of the Castlecliffian is recognised by the incoming of the genus Pecten to the New Zealand area, and when Dr Fleming wrote the Wanganui Bulletin he knew of Pecten only from the shellbeds well east of Kai Iwi, the oldest in the Kupe Formation. However, we now know that the oldest specimens of Pecten occur in a zone of scattered shells about 4feet above the base of the Upper Westmere Siltstone, so it seems logical to regard the shelly layer at the base of this bed (the Kaikokopu Shell grit member) as the base of the Putikian Substage. Fossils in the

Kaikokopu are quite interesting as Anchomasa similis can be seen in place boring into the top of the underlying siltstone, and we recently collected the first Castlecliffian penguin bone from the shell layer.

Shells are richly concentrated in the next bed, the Kupe Formation, made up of five shellbeds with slightly different proportions of bivalves and gastropods. The upper one has a rich layer of Pecten modestus kupei, and this is the only place this subspecies occurs.

We next come to the section exposed in the little gully which is all that remains of the 'Pinnacles', the best place on the whole coast to collect fossils. The most richly fossiliferous beds at the head of the gully are the Pinnacle Sand, overlain by the much muddier Tainui Shellbed, and all the cassids, Coluzea, Pterynotus, etc., etc., come from these two beds. They are underlain by the Lower Castlecliff Shellbed, a three foot bed of concentrated shells, and the Seafield Sand, a sparsely fossiliferous sandstone with many Antisolarium.

The Tainui Shellbed is the most richly fossiliferous unit in the whole section, and is the only bed some species occur in, such as Pterynotus zelandicus and Pecten novaezelandia tainui. This firm muddy bed can be seen gradually descending the cliff for about a mile and a half towards Castlecliff, and is easiest to collect, and richest, in a projecting rock called 'the buttress', where it is at beach level, but now hidden from the beach by the extensive sand dunes that have formed in front of the cliff since the moles were built at the mouth of the Wanganui River. Above the Tainui Shellbed you can collect easily from the sparsely fossiliferous Shakespeare Cliff Siltstone, in which Iredalula striata is common, and the overlying Shakespeare Cliff Sand, in which Astrea and Murexsul octagonus are fairly common at the base of an outcrop east of the 'buttress'. The higher units recognised by Dr Fleming (refer diagram) are now almost completely covered by sand dunes or by grasses on the cliff face, and you can't collect from them without a considerable amount of work.

The uppermost beds of the Castlecliffian are not seen in this section but are found to the east of the Wanganui River, in the hill behind Putiki and, especially at Landguard Bluff. This is a low hill between Wanganui airport and the river, and if you walk down from the old airport road, climb down the cliff to the river, and walk down the river edge in the direction of the sea, below the highest part of the bluff you come to a 20 ft high outcrop of soft brown sand, the Landguard Sand, containing abundant Pecten novaezelandiae aotea. This is almost the youngest bed of the Castlecliffian,

and the shelly bed just above has poor shells. The over lying gravels are the lowest beds of the Hawera Series, late Pleistocene series of glacial and interglacial stages of New Zealand.

The very shallow water marine sands and sand dunes covering the cut surface on the Castlecliffian and older rocks is called the Rapanui Formation; and this can be seen parallel to the horizontal terrace surface and at a clear angle to the underlying Castlecliffian rocks all the way along the cliffs. The formation is probably about 100,000 years old, and although it contains fossils at Hawera and along Waverly Beach, it doesn't along the Nukumaru to Castlecliff part of the cliffs.

Collecting Fossils

Refer to article in 'Cookia' Vol 1.

It is essential that collectors keep separate collections for specimens from different beds. In past visits to this area, some of our more senior members, who should have known better, were seen to put all the shells from all the beds in one container. The specimens so collected are useless for scientific purposes. You must keep separate collections of fossils from separate beds. In a place like the 'Pinnacles' where blocks from different formations have fallen down it's allowable to make a collection labelled 'Pinnacles' as geologists realise which 2 or 3 beds can be collected at this point, but elsewhere please keep a separate collection from each bed. The reasons are numerous but mainly involve working out a faunal list foreach bed so that such things as the age, the sea temperature when it was deposited, the depth in which it was deposited, the current action, and so on, can be worked out from the faunal list. We have many old collections labelled 'Castlecliff' made before Dr Flemings work in the 1940's and 1950's, but later collections just labelled Castlecliff are useless as a locality.

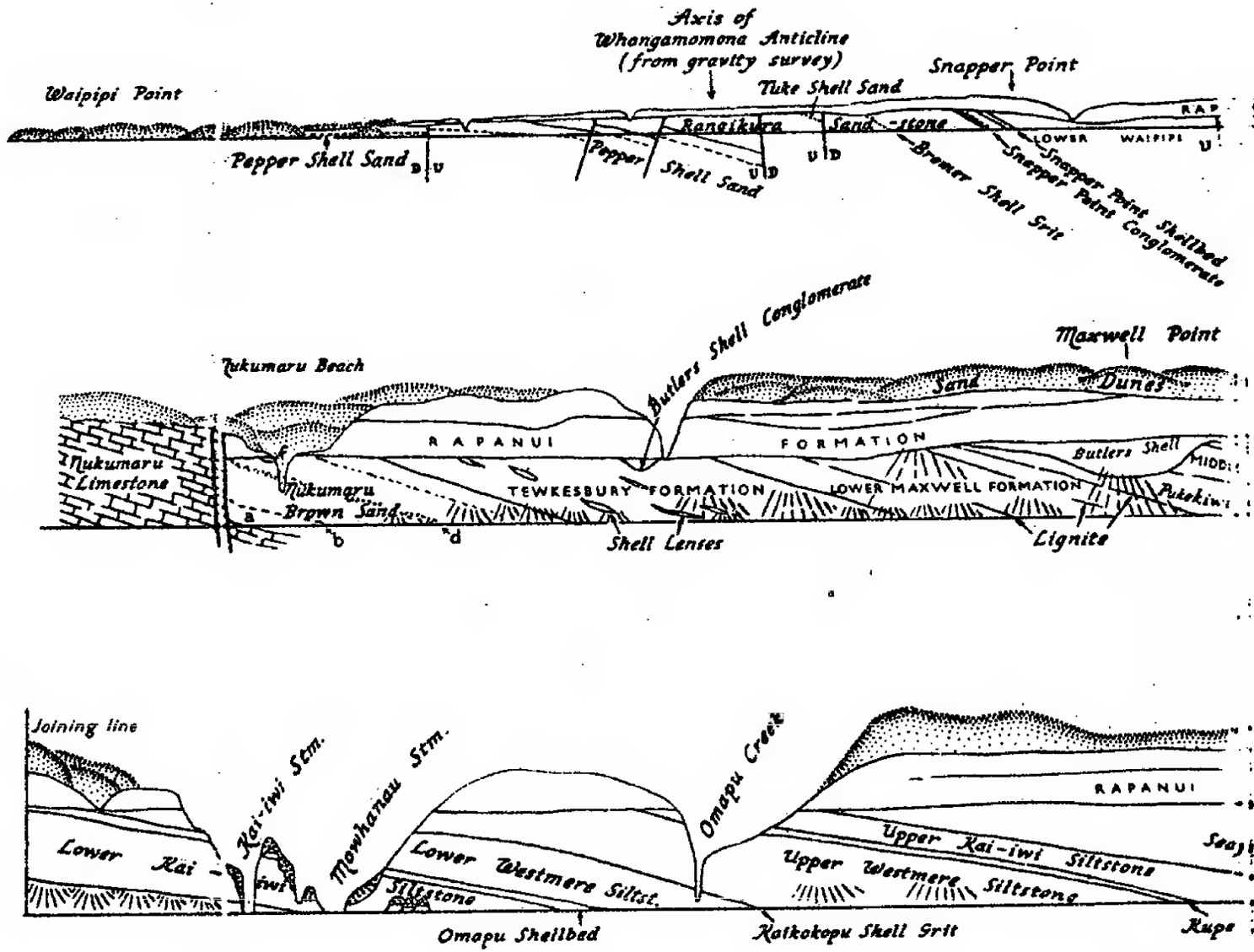
To Accompany Bulletin No 52.

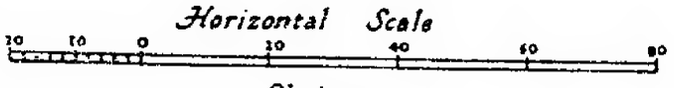
COASTAL SECTIONS Waverley Sheet N.137

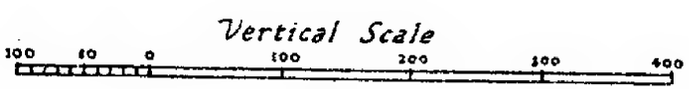
Dune Sand
Alluvium — Recent Series

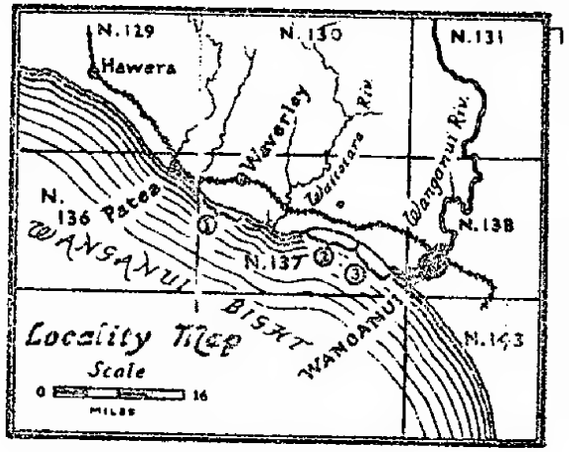
Rapanui Formation — Hawera Series

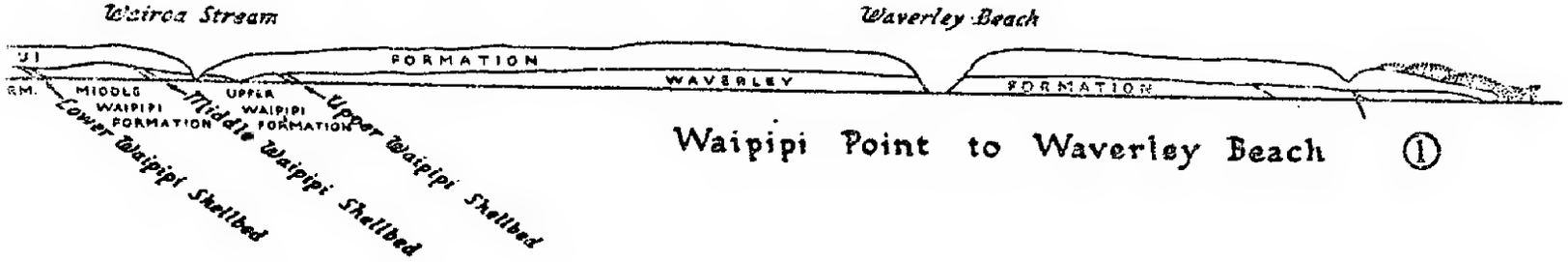
Norsetown Sand	Shakespeare Group	Castlecliffian	WANGANUI SERIES
Waraka Siltstone			
Upper Castlecliff Shellbed			
Shakespeare Cliff Sand			
Shakespeare Cliff Siltstone			
Tainui Shellbed			
Pinnacle Sand			
Lower Castlecliff Shellbed			
Seafield Sand			
Upper Kai-iwi Siltstone	Kai-iwi Group		
Kupe Formation			
Upper Westmere Siltstone			
Lower Westmere Siltstone			
Omapu Shellbed			
Lower Kai-iwi Siltstone			
Kaimatira Pumice Sand			
Upper Okehu Siltstone	Okehu Group		
Okehu Shell Grit			
Lower Okehu Siltstone			
Butlers Shell Conglomerate			
Upper Maxwell Formation	Nukumaru Maxwell Group	Nukumaruan	
Nangahou Siltstone			
Middle Maxwell Formation			
Pukekiwi Shell Sand			
Lower Maxwell Formation			
Tewkesbury Formation			
Nukumaru Brown Sand	Nukumaru Group		
Nukumaru Limestone			
Okiwa Group	Waitotaran		
Paparangi Group			
Waverley Formation	Waipipi Formation		
Upper Waipipi Shellbed			
Middle Waipipi Shellbed			
Lower Waipipi Shellbed			
Snapper Point Shellbed	Whenuakura Group		
Snapper Point Conglomerate			
Bremer Shell Grit			
Tuke Shell Sand			
Pepper Shell Sand	Rangikura Formation		



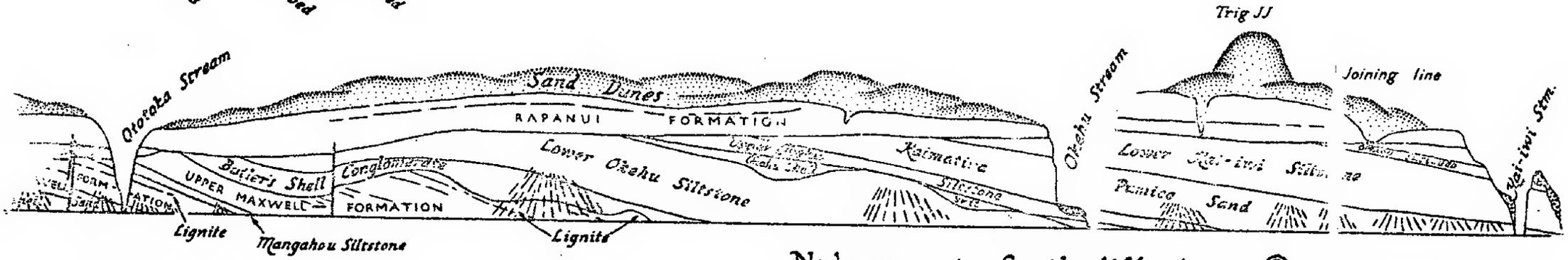




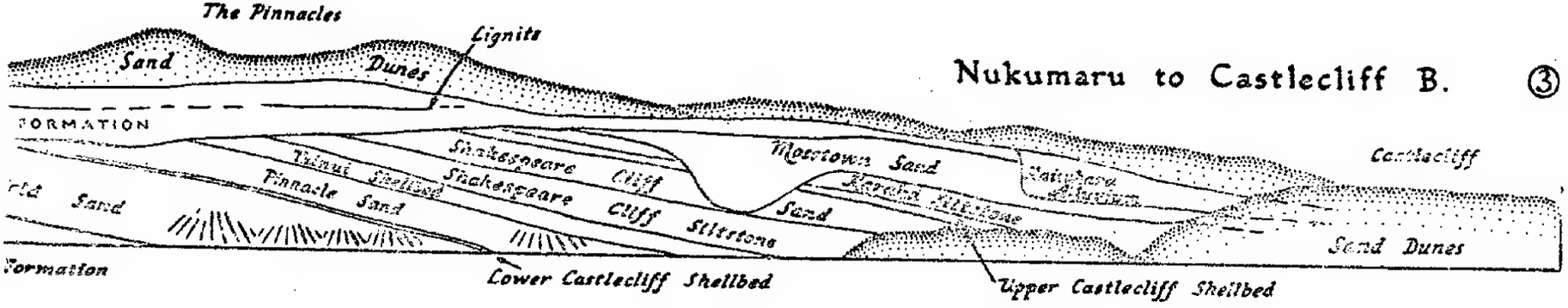




Waipipi Point to Waverley Beach ①



Nukumaru to Castlecliff A. ②



Nukumaru to Castlecliff B. ③

Drawn by E. H. Hyde 1950

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NEW ZEALAND Turritellidae

A. G. Beu

Turritellidae are a family of tall, narrowly tapering gastropods with sculpture almost entirely of low spiral cords, and the similarity of shape and sculpture throughout the family makes them rather difficult to identify. They are common all around the world in shallow to moderately deep water (500 fathoms), crawling on and shallowly burrowing in soft sediments and feeding by filtering fine particles out of bottom detritus with their ciliated gill filaments, much as bivalves do.

In a series of papers and paleontological bulletins over a number of years, Dr J. Marwick has made the Turritellidae his special interest (Marwick 1957, 1971). Examination of large collections of live collected turritellidae from Northland, particularly the Bay of Islands collections of Graham Clifford, has shown that several of the species named by early workers and recognised by Marwick are part of the variation of Zeacolpus (Stiracolpus) pagoda, and one name should be synonymised in Maoricolpus, so Powell's list of turritellids in "Shells of N.Z." reduces to :

Maoricolpus roseus roseus (Quoy and Gaimard, 1835)
roseus manukauensis Powell, 1931
Zeacolpus (Zeacolpus) vittatus (Hutton, 1873)
(Stiracolpus) ahiparanus Powell, 1927
ascencus Marwick, 1957
blacki Marwick, 1957
delli Marwick, 1957
knoxi Marwick, 1957
knoxi tardior Marwick, 1957
pagoda (Reeve 1849)
symmetricus (Hutton,1873)

Important features used in identifying turritellid shells are :

1. the outer-lip sinus : all turritellids have a rounded embayment in the outer lip, sometimes continuing on to the base, and the depth and shape of the curve differs from genus to genus. The sinus shape can be seen in the growth lines if the lip is broken. However, living N.Z. turritellids all have similar, moderately deep sinuses.

2. the protoconch: protoconchs differ widely in the family and many overseas genera have very distinct ones that are easily identified. However, again N.Z. ones are basically similar, although useful for separating genera. In Zeacolpus the protoconch is relatively large and bulbous - of about one smooth,rounded whorl; in Maoricolpus it is minute, of two and a half smooth, tall, narrow whorls, tapering to a pointed apex.

3. the spire angle: in general, species of Maoricolpus have a wider spire angle and a shorter shell than species of Zeacolpus, although some species of Z.(Stiracolpus) such as symmetricus are relatively broad.

4. the spiral sculpture: the strength and spacing of the spiral cords and the order in which they appear on the juvenile shell are the main criteria distinguishing species of turritellids, especially Stiracolpus. Several systems of lettering the cords for quick identification of them in descriptions have been proposed by Finlay and overseas workers, but Dr Marwick's is the one generally used now, and I give a copy of

his figure of letters applied to cords at the back of this article together with a copy of his figure of the protoconch and juvenile whorls of a specimen of Stiracolpus.

The easiest way to identify species of Stiracolpus is by comparison with Dr Marwick's figures of the sculpture and outline of the juvenile whorls (the earliest 3-4 whorls after the protoconch, called neanic whorls by Marwick) and so I have included copies of Marwick's figures of the juvenile stages of all the living species of Stiracolpus.

The N.Z. Turritellids:

Maoricolpus roseus (Figs.5,6): easily recognised by its reddish brown colour its wide spire angle, its large size and by the flat-sided whorls bearing a large number of similar spiral cords. Abundant in shallow water throughout New Zealand. Two variants have been named : M.roseus manukauensis Powell is a tall, narrow form, of similar shape to Zeacolpus finlayi Powell is based on shells with spirals B and C stronger than the others, but this form is common in Nukumaruan rocks of Hawke's Bay where it intergrades with M.roseus and occasional Northland beach shells also intergrade with M.roseus.

Zeacolpus (Zeacolpus) vittatus (Figs.7,8): large, with very narrow spire angle, relatively large, exert, bulbous protoconch, and sculpture of relatively few low, bright red-brown spiral cords on a cream background. Throughout N.Z. relatively uncommon on beaches but commonly dredged in shallow water.

Zeacolpus (Stiracolpus) : a group of small species, almost all with narrow spire angles, and most with few, prominent spiral cords (usually A, B and C prominent).

Z. (Stiracolpus) ahiparanus (Fig.9): spiral B is extremely prominent throughout the whole shell, giving it a very steeped, keeled outline; uniform medium brown. Western Northland only, dredged in shallow water. A very distinctive species.

Z. (Stiracolpus) ascencus (Fig.15): all spirals are very weak and low for Stiracolpus, and B. protrudes more than the others on a strongly angled whorl. White, but all collected dead. Dredged from 200-500 m off eastern South Island and on the Chatham Rise, often with Z. symmetricus and Z. knoxi.

Z. (Stiracolpus) blacki (Fig.18): large for subgenus, with slender spire and flat-sided whorls, spiral B begins first, and angles early whorls, and A and C are soon almost as strong; adult sculpture is of equally strong, high, narrow, widely spaced A, B and C with 3-4 fine threads in each interspace. Usually red-brown; common on Paraparaumu and Waikanae beaches, dredged in deep water (100 - 200 m) around Mernoo Bank, Cook Strait, Kapiti.

Z. (Stiracolpus) dolli (Figs.19,20): medium to small, with rounded whorls; main spirals relatively broad and prominent, separated by interspaces wider than the cords, of which space A-B is wider than B-C. B appears first and is often strongest over the whole shell, and while C is strong early on, it is usually weak on adult whorls which may then appear biangulate. Colour fawn to light brown, often with brown axial lines making brown dots on the spiral cords. Common in shallow dredgings, in a few to 50 m in Wellington Harbour, down to eastern South Island and in Fiordland.

Z. (Stiracolpus) knoxi (Fig.16,17): medium to small, whorls rounded, adult shape and sculpture similar to Z. delli but juvenile very different as A appears late and leaves a hollow shoulder on the first two whorls. White.

The subspecies knoxi tardior is from similar depths (often rather deeper) and in the same area as knoxi knoxi, and is based on shells with more angled whorls than in knoxi, caused by more prominent B. Marwick was doubtful of the distinction and it seems best to regard them as one variable species. Deep water (90 to 600 m) around the Chatham Islands.

Z. (Stiracolpus) pagoda (Figs.10-14): shell relatively large for the subgenus, brightly coloured, with a narrow spire and highly varied spiral sculpture. Generally B predominates over other spirals, and A and C are weak, and always all the main spirals are low, narrow and widely spaced, and almost matched lower down the shell by some of the secondary threads. The form pagoda powelli is one in which A remains weak over the whole shell while B and C are relatively strong, giving the shells a biangled outline; Marwick was puzzled by its relationship to pagoda as he had powelli from a few dredged stations only, and regarded it as a depth form, but as powelli is a common beach shell in Northland and at Coromandel I regard it as one variable species. Marwick had seen only the type material of maorius and mixtus and one other lot of mixtus, but recent large collections show that maorius is based on specimens of pagoda in which all main spirals are very weak, so that the secondary spirals are about the same strength as the main ones, and mixtus is based on occasional specimens of pagoda in which spiral B is stronger than the others. I think all these forms are part of the variation of the single species Z.pagoda.

The colour of fresh shells is greyish fawn with many closely spaced, wavy, red-brown axial colour lines. North Cape to Coromandel Peninsular, in shallow water and washing up on beaches.

Z. (Stiracolpus) symmetricus (Fig.3,4): the common large, relatively short and broad, strongly spiralled, white shell of Otago and southwards, often collected at Stewart Island. Spirals A, B and C are all strong, broad, and relatively closely spaced on rounded whorls.

REFERENCES

MARWICK, J. 1957. New Zealand genera of Turritellidae, and the species of Stiracolpus. N.Z. Geological Survey Paleontological Bulletin 27.

1971. New Zealand Turritellidae related to Zeacolpus Finlay (Gastropoda). N.Z. Geological Survey Paleontological Bulletin 44.

FIGURES

Fig.1. Marwick's figure of lettering of spiral cords of *Stiracolpus*.

Fig.2. Marwick's figure of the apex of *Stiracolpus*; one whorl extends from X to W.

Fig.3,4. *Zeacolpus (Stiracolpus) symmetricus*, X8 and X3½.

Fig.5,6. *Maoricolpus roseus*, X8 and X2.

Fig.7,8. *Zeacolpus (Zeacolpus) vittatus*, X8 and X2.

Fig.9. *Z. (Stiracolpus) ahiparanus*, X12½.

Fig.10,14. *Z. (Stiracolpus) pagoda*, apices of the named forms (10 *powelli*; 11,13, *pagoda*; 12, *maorius*; 14, *mixtus*), all X12½.

Fig.15. *Z. (Stiracolpus) ascencus*, X12½.

Fig.16. *Z. (Stiracolpus) knoxi knoxi*, X12½.

Fig.17. *Z. (Stiracolpus) knoxi tardior*, X12½.

Fig.18. *Z. (Stiracolpus) blacki*, X12½.

Fig.19,20. *Z. (Stiracolpus) delli*, X12½.

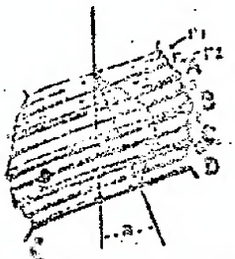

Fig. 1: Diagram showing primary (A, etc.), secondary (r, etc.), and tertiary (r1, etc.) spirals, also a growth line and the growth-line angle (α).

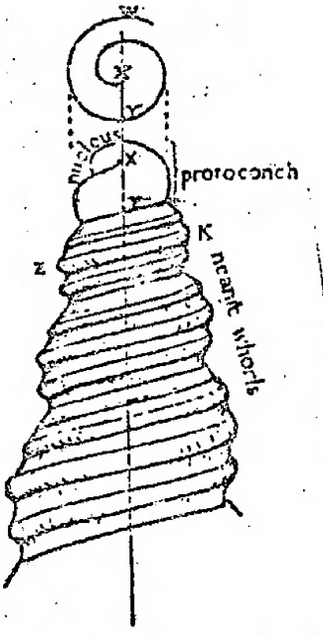

Fig. 2: Protoconch and neanic whorls of *Zeacolpus (Stirecolpus) symmetricus*, showing method of counting whorls.